Fiscal Storms:
Public Spending and Revenues in the Aftermath of Natural Disasters

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Working Paper No. 08-09
December 2008

Abstract

Recent research in both the social and natural sciences has been devoted to increasing our ability to predict disasters, prepare for them and mitigate their costs. Curiously, we appear to know very little about the fiscal consequences of disasters. The likely fiscal impact of a natural disaster has not been examined before in any comparable or comparative framework. We estimate and quantify the fiscal consequences of natural disasters using quarterly fiscal and disaster data for a large panel of countries. In our estimations, we employ a panel VAR framework that is similar to Burnside et al. (Journal of Economic Theory, 2004), that also controls for the business cycle. We find fiscal behavior in the aftermath of disasters in developed countries that can best be characterized as counter-cyclical. In contrast, we find pro-cyclical decreased spending and increasing revenues in developing countries following large natural disasters. We quantify these effects.

Keywords: natural disasters, fiscal policy

JEL codes: E62, O23, Q54

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> The canton of Unterwald in Switzerland is frequently ravaged by storms and inundations, and is thereby exposed to extraordinary expences. Upon such occasions the people assemble, and every one is said to declare with the greatest frankness what he is worth in order to be taxed accordingly.
>
> (from *The Wealth of Nations* by Adam Smith, book V chapter II)

1. Introduction

Natural disasters have resulted in significant economic and human loss long before Adam Smith wrote about the Unterwald. Major catastrophic events—recently the Indian Ocean tsunami, the Kashmir and Sichuan earthquakes and Hurricane Katrina—repeatedly bring the human and material cost of these crises to the forefront of public attention worldwide. Natural disasters also figure prominently in controversial discussions about global warming, especially in relation to the attendant changes in the patterns of climatic events and sea levels that are predicted to accompany such warming (IPCC, 2007).[1] The United Nation's *Integrated Regional Information Network* notes, "Over the past decade, the total [number of people] affected by natural disasters has tripled to 2 billion." (IRIN, 2005). Therefore, much research in both the social and natural sciences has been devoted to increasing our ability to predict disasters, prepare for them and mitigate their costs. Curiously, we are unaware of any research that attempts to quantify the impact of natural disasters on the public purse. We appear to know very little about the typical fiscal consequences of disasters.

[1] Increasing levels of greenhouse gases, changing sea, land and air temperatures, rising sea levels, changing patterns of rain and snow and an unstable climate are all likely catalysts of future events.

In developing the EM-DAT international database on disasters, a significant research effort has gone into measuring the primary costs of disasters in terms of human lives lost, the number of people directly affected, and the damage to property and infrastructure. In a recent emerging literature, several papers have used this data to examine the determinants of these economic costs (Anbarci et al., 2005; Kahn, 2004; Raschky, 2008; and Skidmore and Toya, 2007). Some further work has estimated the short- and long-run secondary impacts of disaster on production, productivity and output (Cavallo and Noy, 2008; Cuaresma et al., 2008; Noy, 2009; and Skidmore and Toya, 2002). However, the likely fiscal impact of a natural disaster has not been examined before in any comparable or comparative framework.

On the expenditure side, the disaster reconstruction costs to the public may be very different than the original magnitude of destruction of capital that occurred. For example, the cost for delivering and supplying populations with both short-term survival needs and longer term reconstruction may be fraught with logistical expenses and can also lead to other macroeconomic dynamics that will have an adverse impact on the government’s fiscal spending. On the other hand, it is also possible that the added reconstruction costs be lower, especially if much of the capital that was destroyed is no longer necessary, was anyway becoming obsolete, is cheaper to replace or because of wide-scale loss of life. In such cases, the fiscal spending burden may potentially be smaller (see Fengler et al., 2008 for more detail on these possibilities).

On the other side of the fiscal ledger, the impact of disasters on tax and other revenue sources has also not been quantitatively examined. To a large extent, impacts on revenue depend on the macroeconomic dynamics occurring following the disaster shock, and the structure of revenue sources (income taxes, consumption taxes, custom dues, etc.) since each may react differently in the aftermath of the disaster event.

Obtaining accurate estimates of the likely fiscal costs of a disaster is useful in enabling better cost-benefit evaluation of various mitigation programs. These should also assist foreign aid organizations and international multilateral institutions in planning and preparing their programs. Another motivation to estimate the fiscal cost is to better enable governments to directly insure against disaster losses, indirectly through the issuance of catastrophic bonds (CAT bonds), or through precautionary saving.[2] The only attempt we know of estimating the likely fiscal insurance needs of a government has been calculated for Belize (Borensztein et al., 2008); though whether these estimates for Belize apply elsewhere is an unexplored question.

We estimate the fiscal consequences of natural disasters using quarterly fiscal data for a large panel of countries. In our estimations, we employ a panel VAR framework that also controls for the business cycle. We find fiscal behavior in the aftermath of disasters in developed countries that can be characterized as counter-cyclical, but pro-cyclical decreased spending and increasing revenues in developing countries following large natural disasters.

2. Data

Our dataset includes 22 developed and 20 developing countries; only data availability restricted our sample (see the appendix for a list of countries). We collected quarterly data on natural disasters and government finance for the period from 1990 to 2005. The natural disaster data is extracted from the EM-DAT database collected by the Centre for Research on the Epidemiology of Disasters (CRED).[3] The EM-DAT database provides information on worldwide disasters compiled from various sources, including UN agencies, non-

[2] Barnichon (2008) calculates the optimal amount of international reserves for a country facing external disaster shocks using a calibrated model.
[3] CRED is based at the Catholic University of Louvain in Belgium. The EM-DAT data is publicly available on CRED's web site at: www.cred.be/

governmental organizations, insurance companies, research institutions and press agencies. Disasters reported in the database include hydro-meteorological disasters (floods, wave surges, storms, droughts, landslides and avalanches), geophysical disasters (earthquakes, tsunamis and volcanic eruptions), and biological disasters (epidemics and insect infestations). CRED defines a disaster as a natural situation or event which overwhelms local capacity necessitating a request for external assistance. Specifically, at least one of the four criteria must be fulfilled: (1) 10 or more people reported killed; (2) 100 people reported affected; (3) declaration of a state of emergency; or (4) call for international assistance.[4]

We construct a series of standardized quarterly disaster variables which reflect the magnitude of these disasters. We aggregate the amount of direct damage from disaster events reported in the EM-DAT database for a country in a given quarter, and then divided by country's GDP from the same quarter of previous year to facilitate cross-country comparisons.[5] The data on quarterly GDP comes from the International Finance Statistics (IFS) database provided by the International Monetary Fund (IMF).[6]

Table 1 reports the summary statistics of our disaster variable. It seems very likely that the financial cost of disaster relates to the level of development. Over the period from 1990-2005, the average damage amount from disasters is more than three times higher in developing countries than in developed countries

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[4] The number of people killed includes "persons confirmed as dead and persons missing and presumed dead"; people affected are those "requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance."

[5] Note that we do not use current GDP to standardize the disaster damage since the current GDP has been affected by the disaster itself.

[6] From the outset, it should be clear that doubts have been expressed about the accuracy of data on natural disasters; especially because often the major source of these data (national governments) has an interest in inflating the measured impact. Yet, since biases should by consistent, using data from one source should provide information about the relative magnitude of disasters and should thus be appropriate for the hypotheses we examine here, and for our empirical predictions regarding an average disaster's likely impact.

(1.095 vs. 0.309). This result is widely reported in the literature, with most explanations emphasizing the capacity of rich nations to better prepare and mitigate the cost of disasters.

Table 1. Summary Statistics of Disaster Variable

Sample	Countries	Obs	Mean	Std. Dev.	Max
Developed countries	**22**	**1408**	**0.309**	**0.735**	**5.921**
Developing countries	**20**	**1251**	**1.095**	**3.033**	**29.179**
Upper Middle Income	*11*	*690*	*0.799*	*2.164*	*11.322*
Lower Middle Income	*9*	*561*	*1.257*	*3.413*	*29.179*

Notes: See the appendix for list of countries. Means and standard deviations are computed from disaster episodes only; number of observations denotes the total number of quarterly observations we obtain for each sample, including 'no disaster' observations.

Data on fiscal policy is primarily taken from the section on government finances in the IFS database (this data was supplemented by data from the Government Finance Statistics CD-ROM, also available from the IMF). The government finance data includes cash flows of the budgetary central government (the Statement of Sources and Uses of Cash) and/or accrual flows of the consolidated general government (the Statement of Government Operations). The two statements broadly correspond to each other, but with variation in the terminology used. In the analysis, we examine five fiscal variables: government consumption (govcon); government revenue (govrev); government payment (govpay); government cash surplus (govsurp); and government outstanding debt (govdebt). We remove seasonal effects using the X12 seasonal adjustment method and present the data as percent of GDP.

Government consumption (line 91f, IFS) consists of consumption expenditure incurred by general government. The government revenue (line c1 /or a1, IFS) consists of four main components: taxes; social contribution; grants; and other receipts. The government payment (line c2 /or a2,IFS) includes compensation of employees, purchase of goods and services, consumption of fixed capital, interest payment, subsidies, grants, social benefits, and other payments. The government cash surplus or government net lending (line ccsd, /or anlb, IFS) is the net result of the net cash balance or net operating balance and the net acquisition of nonfinancial assets. The government outstanding debt (line c63 /or a63, IFS) refers to the direct and assumed debt of the reporting level of government.

Table 2 displays the main descriptive statistics of the fiscal variables. The size of government is clearly larger in developed countries. However, upper-middle income countries have on average lower fiscal deficits than developed countries while the lower-middle income countries have the largest average deficits (the sample mean of govsurp = -2.3% of GDP). Notice that the outstanding debt variable contains substantially fewer observations, and should be interpreted with caution. In addition, though the government debt is usually stated in percent of annual GDP, the debt data presented here is divided by quarterly GDP.

Table 2. Summary Statistics of Fiscal Variables

Variable	Sample	Cou	Obs	Mean	Std. Dev.	Min	Max
govcon	**Developed**	**22**	**1352**	**19.498**	**4.048**	**10.956**	**29.785**
	Developing	**20**	**1052**	**14.635**	**5.648**	**5.452**	**35.181**
	Upper Middle Inc.	*11*	*596*	*16.832*	*5.871*	*7.796*	*35.181*
	Lower Middle Inc.	*9*	*456*	*11.763*	*3.746*	*5.452*	*23.335*
govrev	**Developed**	**20**	**843**	**23.489**	**13.945**	**3.339**	**59.351**
	Developing	**17**	**745**	**17.219**	**10.208**	**2.579**	**68.503**
	Upper Middle Inc.	*9*	*388*	*17.271*	*13.292*	*2.964*	*68.503*
	Lower Middle Inc.	*8*	*357*	*17.162*	*5.070*	*2.579*	*34.991*
govpay	**Developed**	**20**	**872**	**25.657**	**14.681**	**1.932**	**57.033**
	Developing	**17**	**737**	**18.329**	**10.428**	**2.470**	**53.917**

	Upper Middle Inc.	*9*	*380*	*17.441*	*13.358*	*2.470*	*53.917*
	Lower Middle Inc.	*8*	*357*	*19.273*	*5.757*	*2.617*	*36.006*
govsurp	**Developed**	**20**	**902**	**-1.122**	**4.279**	**-21.220**	**18.760**
	Developing	**16**	**745**	**-1.292**	**3.414**	**-17.844**	**18.726**
	Upper Middle Inc.	*8*	*388*	*-0.359*	*3.614*	*-17.844*	*18.726*
	Lower Middle Inc.	*8*	*357*	*-2.307*	*2.859*	*-13.717*	*10.039*
govdebt	**Developed**	**11**	**628**	**37.012**	**20.553**	**1.664**	**75.396**
	Developing	**7**	**300**	**23.471**	**19.381**	**1.466**	**74.069**
	Upper Middle Inc.	*5*	*236*	*26.157*	*20.376*	*5.329*	*74.069*
	Lower Middle Inc.	*2*	*64*	*13.568*	*10.366*	*1.466*	*30.156*

3. Methodology

Eichenbaum and Fisher (2005) estimate the impact of the 9/11/2001 terrorist attacks on the U.S. government's fiscal accounts. Our aim in this paper is similar to theirs; we would like to describe the typical fiscal policy response following a large exogenous shock, a natural disaster, in a panel of developed and developing countries. In terms of the methodology we use, this paper is closest to Burnside et al. (2004) that described macroeconomic developments in the United States following three large exogenous fiscal shocks. The shocks they identify are the Korean War, the Vietnam War, and the Carter-Reagan military build-up. In their work, they use a VAR methodology that is in principle identical to ours; though our use of a panel necessitates a different estimation procedure.[7]

We estimate a panel vector autoregression (PVAR) model and the corresponding impulse-response functions. The reduced form equation is:

[7] Two other examples of a VAR estimation with fiscal data but in different contexts are Blanchard and Perotti (2002) and Ilzetzki and Végh (2008).

$$\boldsymbol{x}_{i,t} = \Phi_0 + \sum_{j=1}^{4} \Phi_j \boldsymbol{x}_{i,t-j} + \boldsymbol{\alpha}_i + \boldsymbol{\lambda}_t + \boldsymbol{e}_{i,t}$$

(1)

where $\boldsymbol{x}_{i,t}$ is a two-variable vector: {*disaster, fiscal*}, $\boldsymbol{\alpha}_i$ is a vector of country-specific effects, $\boldsymbol{\lambda}_t$ is a vector of time-effects, and $\boldsymbol{e}_{i,t}$ is an i.i.d. disturbance vector. Specifically, the bivariate vector {*disaster, fiscal*} encompasses five model specifications that correspond with the five fiscal variables we examine: government consumption, revenue, payments, surplus and debt.

As suggested in Love and Zicchino (2006), the original variables are time-demeaned and the fixed-individual effects are removed by Helmert transformation method.[8] We test for stationarity by implementing a number of panel unit root tests. The test results are reported in Table 3A and 3B; in all cases we clearly reject the unit root null. The model is estimated using a generalized method of moments (GMM) estimation with untransformed variables used as instruments for transformed variables. Numerical impulse-response is computed from the estimated PVAR coefficients. We perform the Monte Carlo simulation to the estimated standard errors to generate 10th and 90th percentiles of the distribution which will be used as a confidence interval of the impulse-response. The number of repetition is 1000 times.

Table 3A. Panel Unit Root Test Results: Developed Countries

Null Hypothesis: Unit Root.

Variable	IPS		ADF-Fisher		PP-Fisher	
	W-stat	P-value	Chi-square	P-Value	Chi-square	P-value
dam	-30.521	0.000	726.104	0.000	956.318	0.000
govcon	-3.816	0.000	84.909	0.000	102.631	0.000
govrev	-3.205	0.001	79.429	0.000	139.665	0.000
govpay	-4.211	0.000	95.005	0.000	137.100	0.000

[8] The procedure implements forward mean-differencing which preserves the orthogonality between transformed and untransformed variables.

govsurp	-7.616	0.000	166.438	0.000	278.033	0.000
govdebt	-2.354	0.009	56.629	0.005	56.106	0.005

Notes: (1) Variables shown are transformed variables using time-demeaned and Helmert fixed-effects transformation methods. (2) Lag length selection is based on AIC criteria. (3) IPS test is the test proposed by Im, Pesaran, and Shin (2003), (4) ADF-Fisher, and PP-Fisher tests are Fisher-type tests using ADF and PP proposed by Maddala and Wu (1999). (5) The test results for time-demeaned variables (without Helmert) are not shown here. However, we find that all the three tests reject the unit root for the disaster variable. The PP-Fisher test results reject the unit root for all fiscal variables, while the IPS and the ADF-Fisher test results fail to reject the unit root for govcon, govrev, govpay, and govdebt.

Table 3B. Panel Unit Root Test Results: Developing Countries

Null Hypothesis: Unit Root.

Variable	IPS		ADF-Fisher		PP-Fisher	
	W-stat	P-value	Chi-square	P-Value	Chi-square	P-value
dam	-21.004	0.000	473.224	0.000	565.735	0.000
govcon	-5.863	0.000	125.510	0.000	138.972	0.000
govrev	-4.323	0.000	91.089	0.000	107.095	0.000
govpay	-4.924	0.000	89.935	0.000	146.984	0.000
govsurp	-9.566	0.000	177.025	0.000	282.540	0.000
govdebt	-1.802	0.036	28.986	0.011	29.160	0.010

Notes: (1) Variables shown are transformed variables using time-demeaned and Helmert fixed-effects transformation methods. (2) Lag length selection is based on AIC criteria. (3) IPS test is the test proposed by Im, Pesaran, and Shin (2003), (4) ADF-Fisher, and PP-Fisher tests are Fisher-type tests using ADF and PP proposed by Maddala and Wu (1999). (5) The test results for time-demeaned variables (without Helmert) are not shown here. However, we find that the PP-Fisher test results reject the unit root for all variables, while the IPS and the ADF-Fisher test results fail to reject the unit root for govdebt.

4. Results

Figures 1A and 1B show impulse-response dynamics of a disaster shock on the fiscal variables for developed and developing countries from the baseline model as specified in equation (1). We set the magnitude of the disaster shock to two standard deviations because we want to examine the impact of large scale disasters. We summarize the cumulative fiscal impact of a large (2 STD) natural disaster over the first six quarters in Table 4A and 4B.

For developed countries, we find that the government consumption ratio rises on impact (0.04 % of GDP) and gradually declines thereafter. The government revenue drops immediately (-1.27 % of GDP) with negative cumulative impact, despite some improvements over time. The government payment, on the other hand, increases on impact (0.46% of GDP) reaching its peak in the third quarter. The government cash surplus is negative on impact which is equivalent to being a net borrower (-0.28 % of GDP) and continually getting worse. Finally, the government outstanding debt increases following the shock (1.07% of GDP), accumulating more than 8% of GDP over a year and a half.

Table 4A. Cumulative Impact: Developed Countries

Variable	dam
govcon	-0.112
govrev	-2.897
govpay	2.378
govsurp	-2.078
govdebt	8.093

From the baseline model with 4 lags.

The dynamic responses of developing countries are quite different from those of developed countries. Developing countries pursue a largely pro-cyclical fiscal policy following a large natural disaster shock. On impact, government consumption, government revenue, government payment, and outstanding debt response negatively, whereas the government cash surplus increases. The cumulative impact shown in Table 4B below emphasizes this surprising pro-cyclical behavior even more. The cumulative government consumption expenditure and government payment decline (-0.68% and -0.33% of GDP), government revenue and cash surplus rise (4.23% and 2.79% of GDP), and outstanding debt decreases (-0.72% of GDP).[9]

Table 4B. Cumulative Impact: Developing Countries

Variable	dam
govcon	-0.679
govrev	4.226
govpay	-0.330
govsurp	2.792
govdebt	-0.724

From the baseline model with 4 lags.

5. Robustness

[9] This finding of pro-cyclical fiscal policy in developing countries is corroborated by Ilzetzki and Végh (2008). They do not examine natural disasters, but demonstrate that unlike developed countries, developing countries follow a pro-cyclical fiscal policy in their reaction to business cycle changes.

In the baseline model, we estimate the PVAR model using four lags based on the AIC (with quarterly data). In this section, we expand the lag length to six and eight lags, to generate the corresponding impulse-response function and cumulative impact. For both sub-samples, results are to a large extent robust and similar to the four lags estimations. However, for the developed countries sample, estimates of the cumulative impact on revenues appears to be sensitive to the number of lags used, while for the developing countries sample, results for payments are apparently not robust. The impulse-response graphs from a model with eight lags are shown in Figure 2A and 2B, and their cumulative impacts are reported in Table 5A and 5B.[10]

Table 5A. Cumulative Impact: Developed Countries

Variable	6-lag	8-lag
govcon	-0.114	-0.081
govrev	-4.367	1.682
govpay	1.588	1.780
govsurp	-1.551	-1.570
govdebt	5.077	5.606

From the model with 6 or 8 lags.

Table 5B. Cumulative Impact: Developing Countries

Variable	6-lag	8-lag
govcon	-0.978	-0.535
govrev	4.508	3.669
govpay	1.857	-3.250
govsurp	2.039	2.070
govdebt	-3.219	-2.777

From the model with 6 or 8 lags.

In addition, we split the developing countries subsample into upper-middle income and lower-middle income countries. Figure 3A and 3B show their impulse-response graphs and Table 6A and 6B report their cumulative impacts.

[10] To save space, we do not show the impulse-response graphs from the model with 6 lags; though they are very similar. Results are available from the authors upon request.

We find that in the cumulative impact, pro-cyclical fiscal policy is to large extent stronger in the lower-income developing countries, suggesting a decreasing ability to use fiscal policy to withstand external negative shocks that is associated with lower income.

Table 6A. Cumulative Impact: Upper-Middle Income Countries

Variable	dam
govcon	0.128
govrev	3.940
govpay	-4.169
govsurp	2.906
govdebt	-2.398

From the baseline model with 4 lags.

Table 6B. Cumulative Impact: Lower-Middle Income Countries

Variable	dam
govcon	-0.938
govrev	-2.336
govpay	-6.614
govsurp	1.918
govdebt	N/A

From the baseline model with 4 lags.

6. Fiscal projections for 2 prototypical cases

One of the purposes for this work is to equip policy makers with an estimate of the likely impact of a large natural disaster on their government accounts. Since different countries have different vulnerabilities to disasters—both in terms of occurrence probabilities, and the different disaster scales, we calculate for several countries the average magnitude of a 2-standard-deviations disaster and from that calculate the disaster's likely fiscal impact. The disaster data for specific countries are presented in table 7 while the cumulative fiscal impacts are presented in table 8.

Table 7. Summary Statistics of Disaster Variable for Selected Countries

Country	Disaster Quarter	Mean	Std. Dev.	Min	Max
Developed countries:					
USA	59	0.059	0.173	0.000	1.197
Germany	19	0.289	0.632	0.002	2.483
Upper-middle income countries:					
Mexico	19	0.093	0.136	0.001	0.496
South Africa	8	0.076	0.140	0.000	0.411
Lower-middle income countries:					

Indonesia	24	1.701	6.042	0.004	29.179
Philippines	41	0.904	2.009	0.001	8.371

Notes: All statistics are calculated from disaster episodes.

Table 8 provides us with the magnitude of the estimated fiscal effects for several countries. These estimates are based on the regression results presented in tables 4A, 6A and 6B. The table clearly demonstrates that while our empirical exercise was aimed at estimating the average effect of a disaster on fiscal variables, the actual magnitude of the estimated effects are different across different countries as these countries face different disaster probabilities and different distributions of the disaster magnitude.

Table 8. Cumulative Impacts – Selected Countries

Variable	USA	Germany	Mexico	S. Africa	Indonesia	Philippines
govcon	-0.027	-0.096	0.008	0.009	-1.660	-0.553
govrev	-0.695	-2.491	0.236	0.276	-4.135	-1.378
govpay	0.571	2.045	-0.250	-0.292	-11.707	-3.902
govsurp	-0.499	-1.787	0.174	0.203	3.395	1.132
govdebt	1.942	6.960	-0.144	-0.168	N/A	N/A

From the baseline model with 4 lags.

7. Policy conclusions

We estimated the fiscal consequences of natural disasters using quarterly fiscal data for a panel of 22 developed and 20 developing countries for 1990-2005 using VARs, as in Burnside et al. (2004). In our estimations, we employ a panel VAR framework that also controls for the business cycle and was developed by Love and Zicchino (2006). We find fiscal behavior in the aftermath of disasters to be different between developed and developing countries. In developed countries, governments seem to be 'leaning against the wind' and increasing spending and cutting taxes following a large disaster event. On the other hand, fiscal policy in developing countries can best be described as pro-cyclical; with governments largely decreasing spending and increasing revenues in the aftermath of large natural disaster events.

While we cannot conclude anything about the reasons behind this differentiated behavior, we observe that this counter-intuitive pro-cyclical fiscal policy in developing countries is well documented in other contexts, most recently by Ilzetzki and Végh (2008). These findings suggest an extra urgency to develop insurance mechanisms that will enable governments to insure against these adverse fiscal consequences. This need is especially acute in developing countries, since the pro-cyclical policy adopted in the aftermath of the disaster leads to further and deeper adverse macro-economic outcomes as a result of these events.

Our quantitative results suggest the exact amount of coverage that governments need to accumulate to insure against these adverse outcomes. For example, given the results we present in table 8, we suggest that given past experiences, the Indonesian government should insure itself, perhaps through the issuance of CAT bonds, to a larger extent than the Philippine government. These are preliminary results, and while suggestive, a mechanism to measure more precisely the amount of insurance needed to account for both the occasional large scale disaster together with frequent smaller disasters needs to be developed.

Once we obtain a benchmark for the likely fiscal dynamics after a disaster event, we can also start to examine the determinants of these effects. For example, different public response to disaster damage may depend on the government accountability to the electorate; i.e., more democratic and competitive regimes with freer speech/press and more transparent institutions are likely to respond more aggressively to disasters than countries whose governments are not responsive or accountable to the population. Besley and Burgess (2002) and before them Sen (1980) suggest several hypotheses that can potentially be examined with more detailed fiscal and disaster data, or data at the sub-national level.

Figure 1A. Selected Impulse-Response Graphs from the Baseline Model for Developed Countries (Two-Standard-Deviation Disaster Shock)

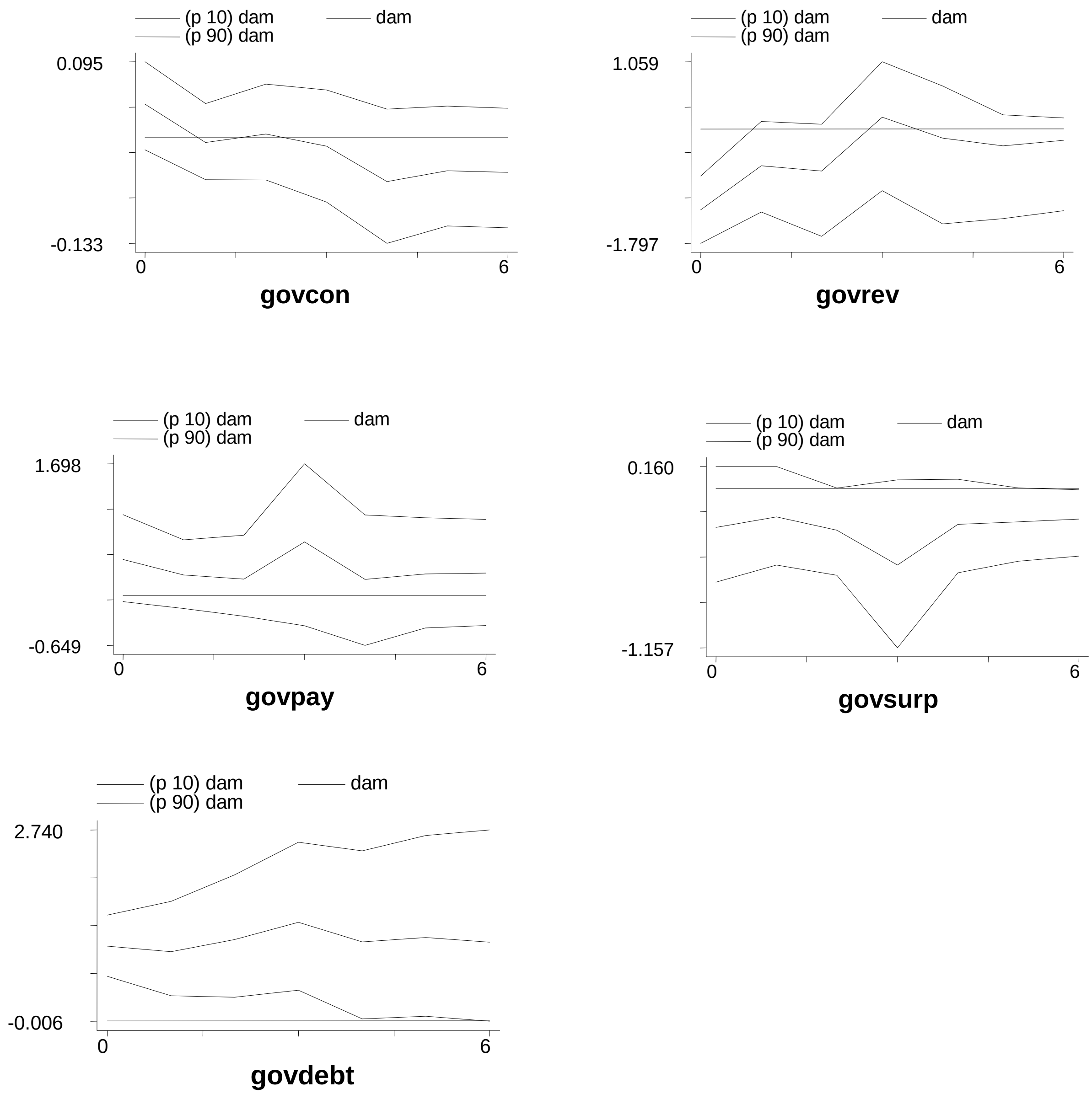


Figure 1B. Selected Impulse-Response Graphs from the Baseline Model for Developing Countries (Two-Standard-Deviation Disaster Shock)

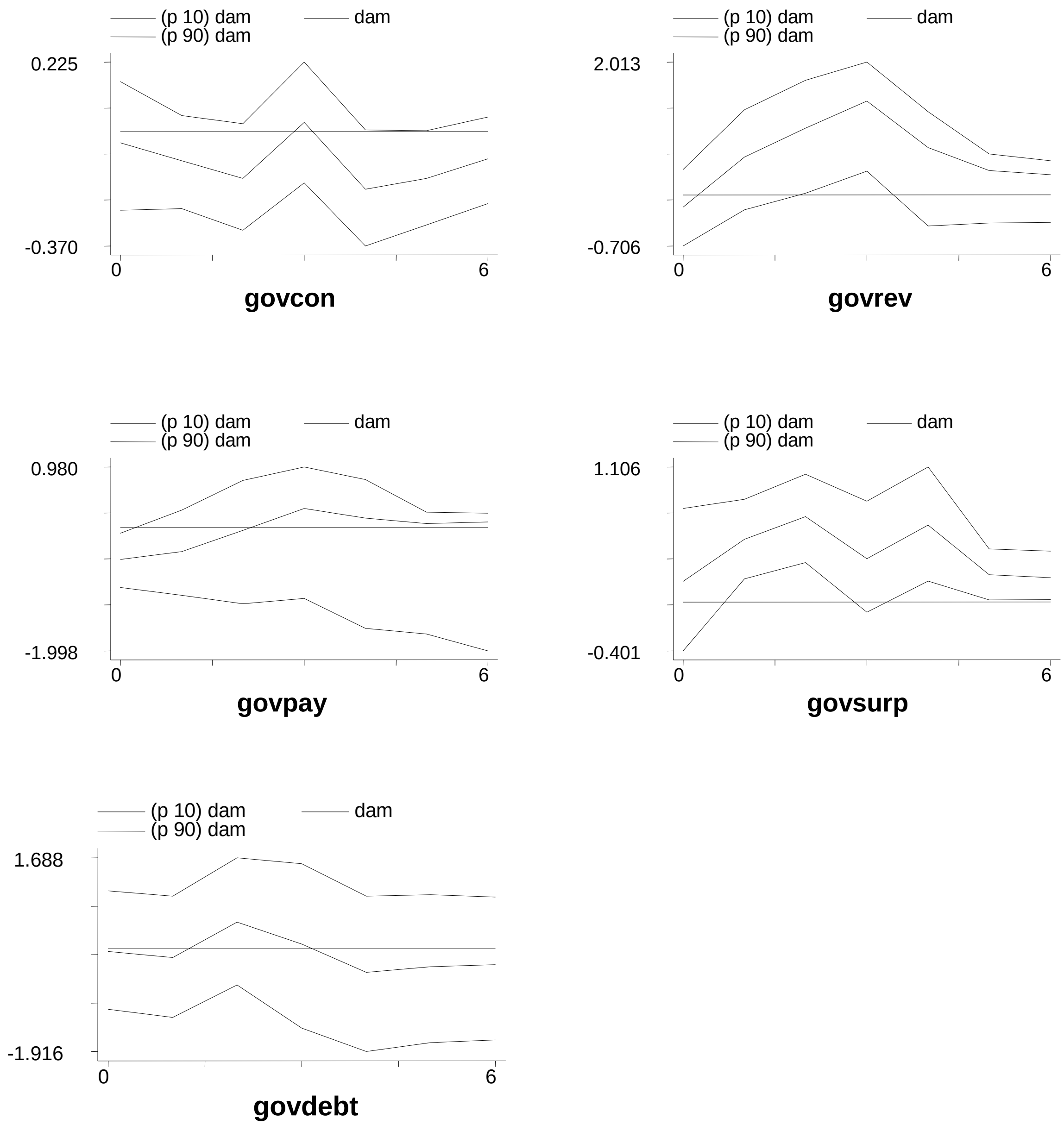


Figure 2A. Selected Impulse-Response Graphs from the Model with 8 Lags for Developed Countries (Two-Standard-Deviation Disaster Shock)

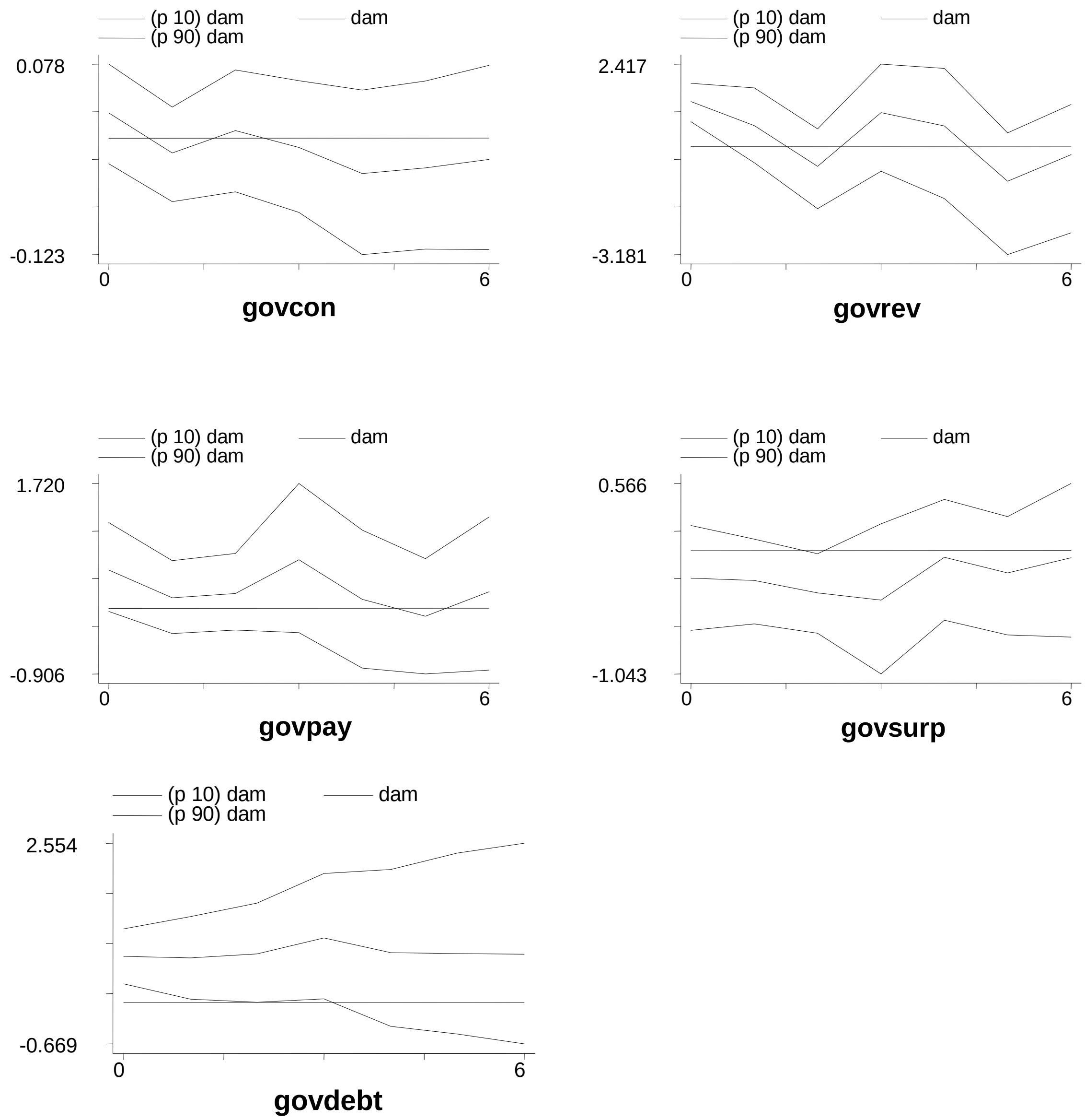


Figure 2B. Selected Impulse-Response Graphs from the Model with 8 Lags for Developing Countries (Two-Standard-Deviation Disaster Shock)

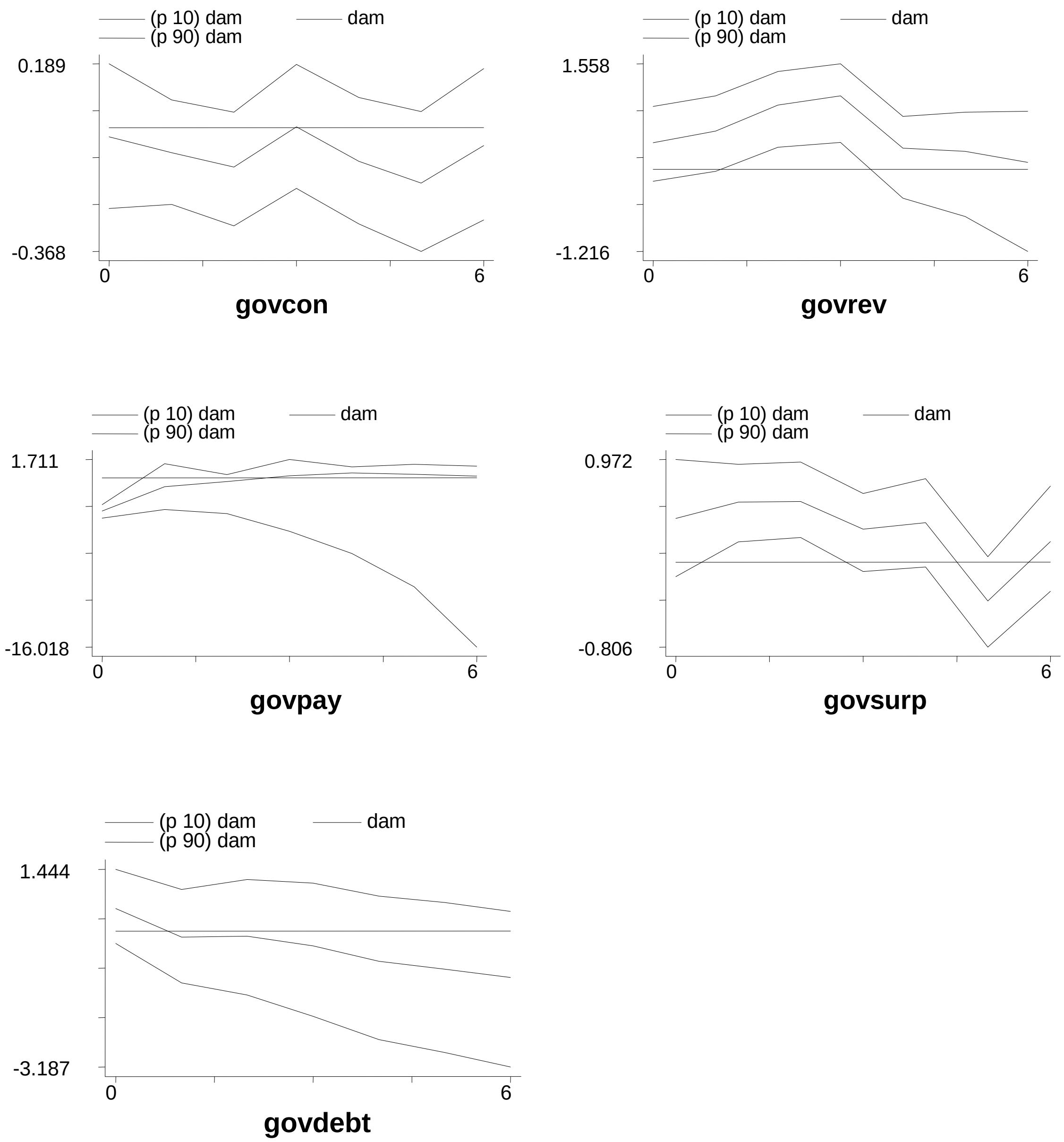


Figure 3A. Selected Impulse-Response Graphs from the Baseline Model for Upper-Middle Income Countries (Two-Standard-Deviation Disaster Shock)

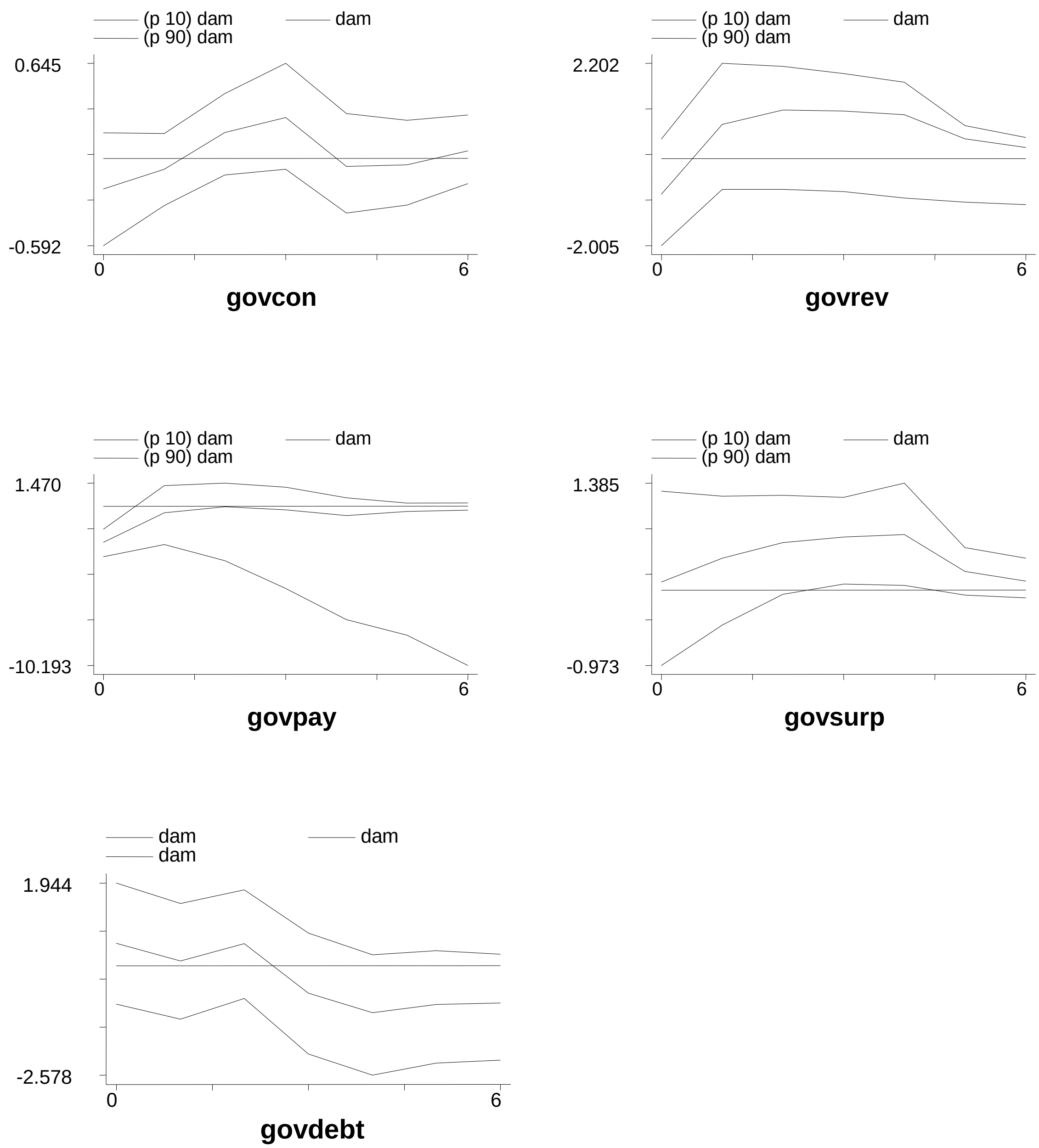
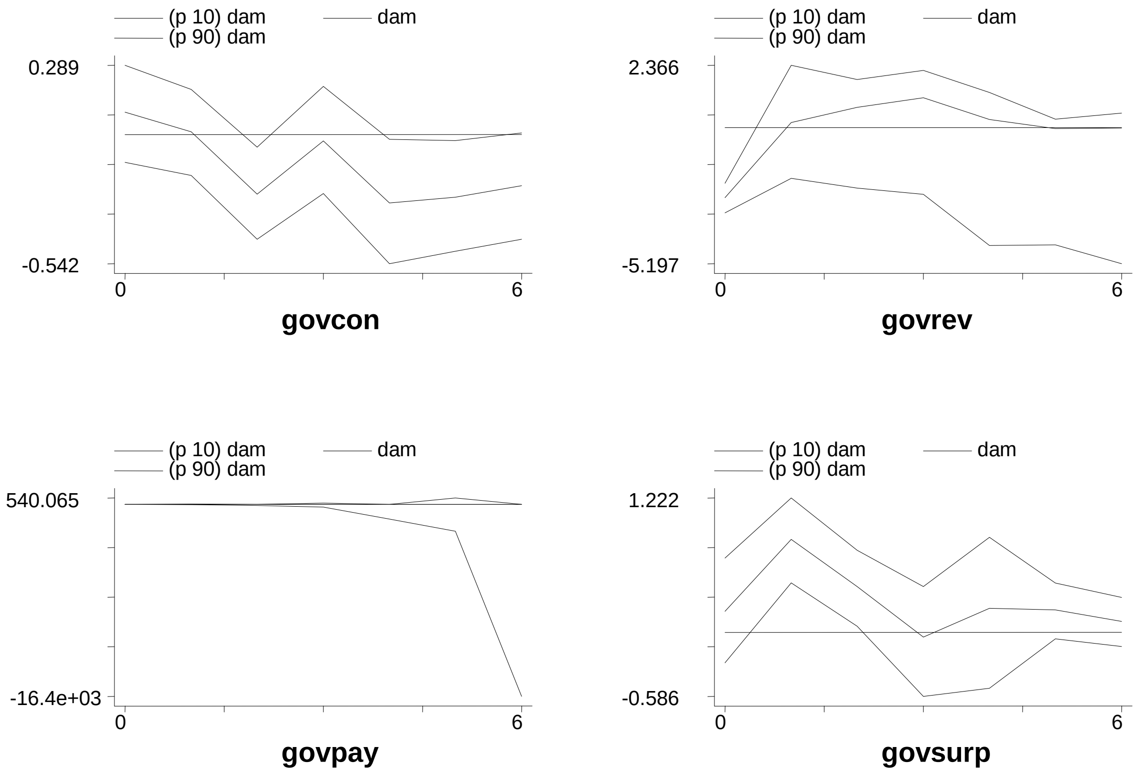


Figure 3B. Impulse-Response Graphs from the Baseline Model for Lower-Middle Income Countries (Two-Standard-Deviation Disaster Shock)



Appendix: List of Countries

Developed	Developing: Upper-Middle Income	Developing: Lower-Middle Income
Australia	Argentina	Bolivia
Austria	Botswana	Colombia
Belgium	Brazil	Ecuador
Canada	Chile	Guatemala
Denmark	Cyprus	Indonesia
Finland	Israel	Iran
France	Malaysia	Peru
Germany	Mexico	Philippines
Iceland	Poland	Thailand
Ireland	South Africa	
Italy	Turkey	
Japan		
Korea		
Netherlands		
New Zealand		
Norway		
Portugal		
Spain		
Sweden		
Switzerland		
United Kingdom		
United States		

Group classification based on the World Bank.

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